國立成功大學 106 學年度碩士班招生考試試題

系　　所：航空太空工程學系

考試科目：自動控制

考試日期：0213，節次：1

※ 考生請注意：本試題不可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. Consider a simplified model for a human leg mechanism shown in Fig.1. The model assumes an applied muscular torque, T_m, viscous damping, D, at the hip joint, and inertia, J, around the hip joint. The weight of the leg is Mg, where M is the mass of the leg and g is the acceleration due to gravity. (PS: The leg is of uniform density, the weight is applied at $L/2$, where L is the length of the leg.)
   (a) Please derive the nonlinear dynamic equation of the system. (5%)
   (b) Apply system linearization at $\theta = 0$ and find the transfer function $\delta\theta(s)/T_m(s)$.(5%)
   (c) Please provide a design guide for the system parameters (J, D, M, L) to make the system without any overshoot when a step torque is applied. (5%)
   (d) Let $J = 0.5(Kg - m^2)$, $D = 0.1(N - m)/rad/s$, $M = 1(Kg)$, $L = 0.2(m)$ and $g = 9.8(m/s^2)$. Design a PD-controller as shown in Fig. 2 such that the closed-loop system is with 10% overshoot and 0.1(sec) setting time. (10%)

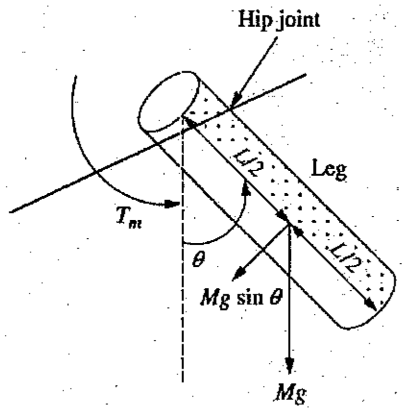

Fig.1

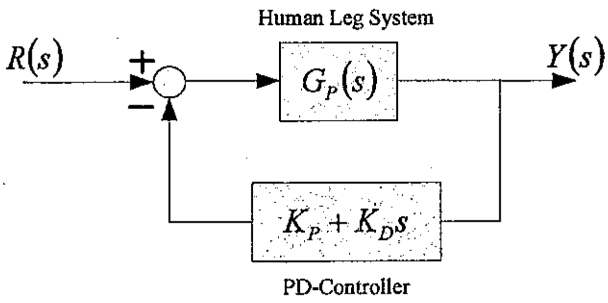

Fig.2

2. For the following open-loop system

$$G(s) = \frac{K(s+4)}{s(s+1.2)(s+2)}$$

Consider an unit feedback control and find the following:

   (a) The range of K that keeps the system stable. (5%)
   (b) The value of K that makes the system oscillate. (5%)
   (c) The frequency of oscillation when K is set to the value that makes the system oscillate. (10%)
   (d) Let K = 10, find the steady state error for the closed-loop system subject to unit step input. (5%)

※ 考生請注意：本試題不可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

3. Consider the control system described as Fig. 3,

(a) Draw the root locus of the system with α as a varying parameter. (15%)

(b) Discuss the effect of the derivative feedback on the closed-loop damping. (5%)

(c) Determine the value of α for the system to be critically damped. (5%)

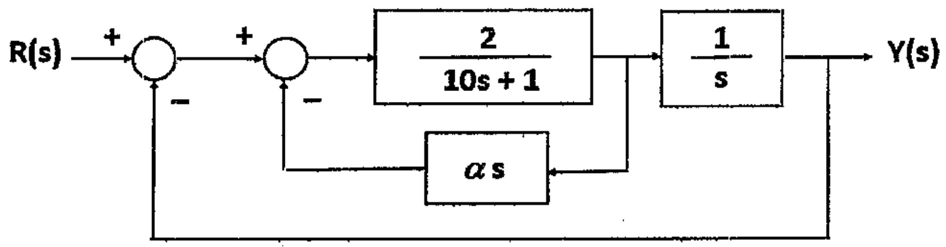

Fig. 3. Two-loop control system

4. Consider a unity feedback system where the open-loop transfer function is given by

$$G(s) = \frac{K}{s(s+1)^2}$$

(a) Draw the Nyquist plot of the open-loop system G(s) with K = 2. (10%)

(b) Draw the Bode diagram of the system G(s) with K = 0.5. (10%)

(c) Find the phase margin of the system for the value of gains K = 0.5. (5%)